IBM® Storage

Multicloud Storage as a Service using vRealize Automation and IBM Spectrum Storage



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Contents

About this document	. 1 . 1 . 2 . 2
for Public Cloud	<u>~</u> e . 3 . 3
End-to-end business solution architecture for storage as service	.5 .5 .5
vRealize Orchestration and vRealize Automation.	. 6 . 8 . 8
Installation of IBM Spectrum Virtualize for AWS Cloud Installing IBM Spectrum Virtualize for Public Cloud	11 11 13
Configuring back-end storage for IBM Spectrum Virtualize for Public Cloud Configuring site-to-site IPSec VPN for hybrid cloud connectivity	14 16
Configuring the VYOS router at on-premises	17 18 21
Configuring IBM Spectrum Connect. Storage space and service management IBM FlashSystem storage system added in IBM Spectrum Connect VMware vRealize Automation XaaS Sorvice catalog	22 22 22 27 28 28
VMware vRealize Automation configuration Creating XaaS service category Create a custom resource. Creating XaaS Blueprints Creating a resource action Configuring catalog items.	29 30 30 31 33 34 35
VMware vRealize Automation: Service Execution	37 38
Notices Trademarks Terms and conditions for product documentation Applicability	39 40 41 41
Commercial use	41 41 41

ii Multicloud Storage as a Service using vRealize Automation and IBM Spectrum Storage



About this document

This document is intended to facilitate the deployment of the Multicloud Solution for Business Continuity and Storage as service by using IBM® Spectrum Virtualize for Public Cloud on Amazon Web Services (AWS). To complete the tasks it describes, you must understand IBM FlashSystem® 7200, IBM Spectrum® Virtualize for Public Cloud, IBM Spectrum Connect, VMware vRealize Orchestrator, and vRealize Automation and AWS Cloud.

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Executive summary

IT organizations today are looking for a tool with which they can deliver complete end-to-end IT services to their lines of business. The IT service might be infrastructure, applications, desktops, or something else.

An organization that provides these IT services wants these services to be delivered securely in a multi-tenant environment with the capability of self-service for the users, while also ensuring compliance with the business policies. With many organizations attempting to leverage multicloud environments where infrastructure is isolated (on-premise and Public Cloud), an orchestrated and automated way of managing the environment becomes more important.

Orchestrating the infrastructure needs multiple entities that are tightly integrated with each other and smartly responding to administrator or user needs. A software-defined environment plays an important role in participating in the overall orchestration.

Integration between service delivery, management, orchestration, automation, and hardware systems is becoming a requirement to support the emergence of software-defined environments. For software-defined environments to provide a benefit, they must understand and manage all of the components of the infrastructure, including storage, and that makes the software-defined storage more relevant and important. The capability of collecting the information from storage systems and providing a simplified multicloud deployment across IBM Storage systems is provided by IBM Spectrum Connect.

vRealize Orchestrator is one product from VMware that enables the orchestration of the infrastructure. With the help of IBM Spectrum Connect, it involves IBM Storage systems in the orchestration for IBM Storage products, such as IBM FlashSystem 7200 and IBM Spectrum Virtualize for Public Cloud running in IBM Cloud or AWS.

The integration of vRealize Orchestrator with vRealize Automation takes the service around infrastructure beyond orchestration. The Advanced Service Designer feature of vRealize Automation with the integration of vRealize Orchestrator enables an organization to offer anything as a service (XaaS) to its users. By using the XaaS feature of vRealize Automation, IBM Spectrum Virtualize Storage System can be delivered as storage as a service in a multicloud environment, whether it is deployed in private cloud or Public Cloud (such as IBM Cloud or AWS).

Scope

This blueprint guide provides a solutions architecture and related solution configuration workflows, with the following essential software and hardware components:

- IBM FlashSystem
- IBM Spectrum Virtualize for Public Cloud on AWS
- IBM Spectrum Connect
- VMware vRealize Automation
- VMware vRealize Orchestration

It also provides detailed technical configuration steps for building an end-to-end business continuity and storage as a service solution in hybrid Cloud environment.

This technical report does not:

- · Provide performance analysis from a user perspective
- Replace any official manuals and documents that are issued by IBM
- · Explain the installation and configuration process of VMware vRealize Suite

Prerequisites

This technical paper assumes the user has basic knowledge about the following products and technology:

- IBM FlashSystem
- IBM Spectrum Virtualize for Public Cloud on AWS
- AWS Cloud
- VMware vRealize suite
- IP networking

Getting started: Storage as service in multicloud environment using IBM Spectrum Virtualize for Public Cloud

This section describes the essential end-to-end storage as a service solution building material.

IBM Spectrum Virtualize for Public Cloud

IBM Spectrum Virtualize for Public Cloud is a version of IBM Spectrum Virtualize that is implemented in a cloud environment, such as IBM Cloud and AWS Cloud. This paper discusses IBM Spectrum Virtualize for Public Cloud running in AWS Cloud.

Designed for software-defined environments, IBM Spectrum Virtualize for Public Cloud represents a solution for public cloud implementations and includes technologies that complement and enhance public cloud offering capabilities.

IBM Spectrum Virtualize for Public Cloud provides for the deployment of IBM Spectrum Virtualize software in public clouds, starting with IBM Cloud and is now available in Amazon Cloud. IBM Spectrum Virtualize for Public Cloud on AWS and IBM Cloud provides a monthly BYOL license that is acquired from IBM passport advantage to deploy and use IBM Spectrum Virtualize for Public Cloud and IBM Cloud to enable hybrid cloud solutions. This offers the ability to have storage as service in a multicloud environment.

Table 1 lists the components of IBM Spectrum Virtualize for Public Cloud.

Items	On AWS Cloud	On IBM Cloud
Storage supported	Amazon Cloud EBS block storage	IBM Cloud Performance and Endurance block storage
Licensing approach	Simple, flat cost per managed terabyte. Monthly licensing purchased through IBM	Simple, flat cost per managed terabyte. Monthly licensing
Platform	IBM Spectrum Virtualize for Public Cloud on AWS installed on EC2 instance	IBM Cloud bare-metal server infrastructure

Table 1 IBM Spectrum Virtualize for Public Cloud at a glance

IBM FlashSystem 7200

IBM FlashSystem 7200 is designed to deliver flexible, affordable scaling and performance:

- Support of NVMe over Fabrics provides for the highest end-to-end storage performance
- Utilization of IBM FlashCore®-enhanced storage media provides extraordinary flash density and storage capacity while achieving low latency in microseconds

FlashCore Modules (FCM) utilize powerful inline, hardware-accelerated compression technology that provides consistent data compression without performance impact across the full range of workloads. The FCMs are designed to support FIPS 140-2 Level 1 encryption. Built-in flexibility allows you to choose various drive types, and supports all three drive types simultaneously within the array:

- FCMs in multiple capacities
- Industry-standard NVMe
- New Storage Class Memory (SCM) drives

Scaling of capacity and performance is dynamic with always online high-performance data compression in the FCMs or with the Data Reduction Pool (DRP) technology using industry standard drives. Effective capacities can range up to four petabytes (PB) in a single 2U enclosure, with the ability to cluster, scale-out, or scale up capacity and performance to 32 PB and eight million input/output operations per second (IOPS).

Each controller contains a hardware compression accelerator based on Intel QuickAssist technology with an available second accelerator. Flexible host interface options include:

- 16 Gbps or 32 Gbps Fibre Channel with FC-NVMe support
- 25 Gbps Ethernet with iSCSI, iWARP, RoCE support, and 10 Gbps iSCSI
- Up to four IBM FlashSystem® 7200 arrays can be clustered and operated as a single system, with 12 Gb, 24 Gb, and 92 Gb SAS expansion enclosures available. It can support up to 760 SAS drives per array controller, 96 NVMe, and 2,944 SAS drives per 4-way clustered system

For more information about IBM FlashSystem specifications, refer to the following link:

https://www.ibm.com/us-en/marketplace/flashsystem-7200

For the purposes of this paper and lab environment, the IBM FlashSystem 7200 is deployed at an on-premises environment. The IBM FlashSystem 7200 combines the performance of flash and the Non-Volatile Memory Express (NVMe) protocol with the reliability and innovation of IBM FlashCore technology and the rich feature set of IBM Spectrum® Virtualize in one powerful new storage platform for your data-driven multi-cloud enterprise.

IBM Spectrum Connect

IBM Spectrum Connect empowers storage teams and other stakeholders by enabling provisioning, monitoring, automating, and orchestrating of IBM block storage in containerized, VMware, and Microsoft PowerShell environments. It offers the same UI for many solutions and environments for a consistent experience. It helps organizations simplify cloud complexity and is available by entitlement to every IBM block storage customer.

VMware vRealize Orchestrator and vRealize Automation

vRealize Orchestrator is one product from VMware that enables the orchestration of the infrastructure and with the help of IBM Spectrum Connect. It involves IBM storage systems in the orchestration.

The integration of vRealize Orchestrator with vRealize Automation takes the service around infrastructure beyond orchestration. The Advanced Service Designer feature of vRealize Automation with the integration of vRealize Orchestrator enables an organization to offer XaaS to its users. By using the XaaS feature of vRealize Automation, IBM Spectrum Storage[™] System (whether at on-premises or at Public Cloud) can be delivered as storage as a service.

End-to-end business solution architecture for storage as service

Figure 1 shows the high-level architecture for building storage as a service in a multicloud environment using IBM Spectrum Virtualize for Public Cloud and vRealize Automation. This paper describes the storage as a service with IBM Spectrum Virtualize for Public Cloud running in AWS, but same architecture can be used for IBM Spectrum Virtualize for Public Cloud running in IBM Cloud.



Figure 1 High-level architecture

IBM Spectrum Virtualize storage family

IBM Spectrum Virtualize for Public Cloud is a software-defined storage solution that helps speed delivery of data across the organization and adds extreme flexibility to cloud deployments. IBM Spectrum Virtualize for Public Cloud virtualizes the Public Cloud block storage in public cloud environments delivering easy data management and enterprise capabilities, such as remote mirroring and IBM FlashCopy® for a host of different deployment platforms. IBM® Spectrum Virtualize for Public Cloud can be deployed on IBM Cloud[™] or AWS Cloud self-service infrastructure as a service (IaaS), all within an Integrated Data Management environment.

IBM Spectrum Connect

IBM Spectrum Connect is a centralized cloud integration system that consolidates a range of IBM storage provisioning, virtualization, cloud, automation, and monitoring solutions through a unified server platform.

IBM Spectrum Connect provides a single-server, back-end location and enables centralized management of IBM storage resources for different virtualization and cloud platforms, including:

- VMware vCenter Server
- VMware vSphere Web Client
- VMware vSphere APIs for Storage Awareness (VASA)

- VMware vRealize Operations Manager
- VMware vRealize Orchestrator (vRO)

Through its user credential, storage system, storage space, and service management options, IBM Spectrum Connect facilitates the integration of IBM storage system resources with the supported virtualization and cloud platforms. At the same time, it provides the foundation for integration with future IBM systems and independent software vendor (ISV) solutions. IBM Spectrum connect can be managed through a standard web browser and a graphical user interface (GUI), or through terminal and command-line interface (CLI).

vRealize Orchestration and vRealize Automation

vRealize Orchestrator from VMware enables the orchestration of the infrastructure and with the help of IBM Spectrum Connect, it involves IBM storage systems in the orchestration.

The integration of vRealize Orchestrator with vRealize Automation takes the service around infrastructure beyond orchestration. The Advanced Service Designer feature of vRealize Automation with the integration of vRealize Orchestrator enables an organization to offer XaaS to its users. Using the XaaS feature of vRealize Automation, IBM Spectrum Virtualize for Public Cloud Storage System can be delivered as storage-as-a-service.

As shown in Figure 1 on page 5, vRealize Automation Center is installed and configured with the required components. vRealize Automation can be configured with a built-in vRealize Orchestrator server or the external vRealize Orchestrator server.

In this example, the external vRealize Orchestrator is used and is enabled. Figure 1 on page 5 shows how IBM storage systems are accessed and used from the VMware environment through IBM Spectrum Connect.

The storage administrator uses Spectrum Connect to select which IBM storage systems (arrays) and what storage resources should be available for use.

IBM Storage Plug-in for VMware vRealize Orchestrator is installed and configured on the vRealize Automation appliance, which enables communication between the embedded vRealize Orchestrator server, and IBM Spectrum Connect Server. IBM Spectrum Connect is configured with the details of the IBM FlashSystem Storage System and IBM Spectrum Virtualize for Public Cloud.

The total integration of vRealize Automation, vRealize Orchestrator, IBM Spectrum Connect, IBM Spectrum Virtualize for Public Cloud, and IBM FlashSystem enables efficient provisioning of storage resources in an overall IT process workflow in a multicloud environment. Logical configuration is shown in Figure 2.



Figure 2 Solution Architecture overview

Configuring on-premises site

This section describes the benefits, features, and configuration overview of IBM FlashSystem 7200.

Configuring IBM FlashSystem 7200

The IBM FlashSystem 7200 system that is used in the lab setup is configured with 24 3.2 TB flash drives. The drives are configured as Tier 0 with IBM Easy Tier®.

To view the system overview page, log in to the IBM FlashSystem 7200 GUI. Then, log in to the cluster IP address by using a supported web browser and click **System** (see Figure 3 on page 8).



Figure 3 IBM FlashSystem 7200 Login window

Use the following guidelines to move through creating a pool to mapping a volume:

1. Click **Pools** \rightarrow **Internal Storage**, as shown in Figure 4.

IBM	IBM FlashSystem 7200	Internal Storage					
\triangle	Dashboard	Drive Class Filter 🏾 🏹		All Interna	1		
~ ₽	Monitoring	All Internal	0,,				
#	Pools	3.49 TiB, Tier 0 Flash	\equiv Actions \bullet	⊽ Filter	÷		
8	Volumes		Drive ID 🖈	Capacity	Use	Status	MDisk Name
			0	3.49 TIB	Member	 Online 	mdisk0
同	Hosts		1	3.49 TiB	Member	🗸 Online	mdisk0
			2	3.49 TIB	Member	 Online 	mdisk0
FF	Copy Services		3	3.49 TIB	Member	🗸 Online	mdisk0
			4	3.49 TiB	Member	 Online 	mdisk0

Figure 4 IBM FlashSystem 7200 disk information

 Next, create a pool. Click Pools → Create Pool and follow the Create Pool wizard. Assign a managed disk (MDisk) to the pool, as shown in Figure 5.

IBM	IBM FlashSystem 7200 F3DPR-CL1	MDisks by Pools		
≏	Dashboard	\oplus Create Pool $:\equiv$ Actions \checkmark		
~	Monitoring	Name	State	Capacity
		Unassigned MDisks (0)		
₿	Pools	> Ext_pool_FS9100Cl2	✓ Online	1.05 TiB
		> Spectrum Scale Pool	✓ Online	6.56 TiB
8	Volumes	✓ SVPC Pool	✓ Online	50.00 Gi
Ē	Hosts	mdisk5	✓ Online	27.76 TiB

Figure 5 Creating IBM FlashSystem 7200 pool

After the pool is created, create a VDisk and map the VDisk to the Windows host:

1. To create a VDisk, click Volumes by Pool \rightarrow Create Volumes, as shown in Figure 6.

IBM FlashSystem 7200 F3DPR	CL1 Volumes by Pool	👍 📳 🕥 supervaer (Security A
Dashboard	Pool Filter 🏼 🍹	SVPC Pool O Configure Remote
	Ext_pool_FS9100Cl2	Configure Pool Allocation Configure Pool Allocation Configure Conf
Pools		
Volumes	Spectrum Scale Pool 5 Volume copies 6.56 TIB Allocated / 31.36 TiB	Of Lease volumes En contra + Au volumes + Desuit Contra + Term Name State S Protocol Type UID Host Mappings Capacity Term
	SVPC Pool	08_34/me 🗸 Deline 5C3 60050745108504437600 Yes 80.00.0/8
	1 Volume copy 50.00 GiB Allocated / 27.76 TiB	

Figure 6 IBM FlashSystem 7200 volume creation

- 2. In the pool-creation window, as shown in Figure 6, select the pool and provide volume information, such as the capacity and name for the VDisk. Also, select whether you want a thin-provisioned volume or a thick volume, and if de-duplication must be enabled or disabled.
- 3. Then, click **Create and Map**, as shown in Figure 7. Follow the instructions that are provided by the wizard and map the volume to the Windows host at the on-premises site.

Basic	Mirrored	Custom	
Create a preset v	olume with all the basic fe	atures.	
SVPC Pool	•		
		Total 27.76 TiB	
Volume Details			
Quantity:	Capacity:	Name:	
1 +	50 GiB	▼ DB_Volume	
Capacity savi	ings:		
Define another	r volumo		
() Denne anothe	volume		
I/O group: Automatic	•		
	hmary blume		

Figure 7 Creating and mapping volume

Installation of IBM Spectrum Virtualize for AWS Cloud

This section describes the high-level installation steps for IBM Spectrum Virtualize for Public Cloud. In the proof-of-concept solution lab test environment that is described here, a two-node IBM Spectrum Virtualize for Public Cloud cluster is configured.

Installing IBM Spectrum Virtualize for Public Cloud

The high-level architecture of IBM Spectrum Virtualize for Public Cloud in AWS is shown in Figure 8.



Figure 8 High-level architecture for IBM Spectrum Virtualize for Public Cloud on AWS

As shown in Figure 8 on page 10, the installation can be done in an existing VPC or a new VPC. The installation is done by using the AWS Marketplace (see Figure 9).

👯 aws marke	tplace							Q 📃	Hello,	lanlongw 🔻
Categories 👻 Deliv	very Methods 👻	Solutions 👻	Migration Mappi	ng Assistant Yo	ur Saved List	Partners	Sell in AWS M	arketplace	Amazon Web Services	Home Help
IB	W	IBM Spect By: IBM Lates IBM Spectrum Vir multicloud solutio Show more Linux/Unix	version: 8.3.0* tualize for Public Clou in for on premises to p	e for Publi d BYOL Markpalce (public cloud data m	c Cloud Offering provid obility, disaster	es a great hy r recovery an	rbrid d cloud	Conti S Ty S Total pricin hosted on c Virginia). Vi	nue to Subscribe save to List pical Total Price \$1.530/hr per instance for services .5xtarge in US East (N. pre Details	
Ove	rview	F	ricing	Usage	2		Support		Reviews	
Product Overview IBM Spectrum Virtualize for Public Cloud is used to build hybrid and multi cloud solutions. You can create storage-based replication for data mobility, disaster recovery, and optimization of your workloads on AWS with this offering. Use IBM Spectrum Virtualize for Public Cloud on AWS in conjunction with your on premises IBM Storayce, SVC, IBM FlashSystem 9100, or over 450 IBM and non- IBM storage appliance to create a hybrid cloud solution that can be used to replicate on premises data to AWS EBS storage. Create workload mobility solutions, or Disaster Recovery/Business Continuity secondary sites on AWS										

Figure 9 AWS Marketplace for IBM Spectrum Virtualize for Public Cloud

To install IBM Spectrum Virtualize for Public Cloud, complete the following steps:

1. Select the network and availability zone, as shown in Figure 10.

Search by ID, or Name tag value
ID of your existing VPC for deployment
The CIDR block for the VPC.
Search by ID, or Name tag value
ID of public subnet 1 in Availability Zone 1 for the quorum node (e.g., subnet-a0246dcd)
Search by ID, or Name tag value
ID of private subnet 1 in Availability Zone 1 for the Workload (e.g., subnet-a0246dcd)
The IP address range that can be used to visit sv_cloud (example for full access: 0.0.0.0/0)

Figure 10 AWS Marketplace for IBM Spectrum Virtualize for Public Cloud (Network Configuration)

2. Select the EC2 configuration (the three types of EC2 are supported). The details of the supported EC2 configurations are shown in Figure 11.

Model	vCPU	Memory (GiB)	Instance Storage (GiB)	Network Bandwidth (Gbps)	EBS Bandwidth (Mbps)
c5.4xlarge	16	32	EBS-Only	Up to 10	3,500
c5.9xlarge	36	72	EBS-Only	10	7,000
c5.18xlarge	72	144	EBS-Only	25	14,000

Figure 11 EC2 instance types

3. After the deployment is completed, the output is displayed (see Figure 12).

Outputs -									
Кеу	Value	Description							
QuorumInstancePublicIP	3.82.248.2	run "ssh -i ssh_key centos@this_I							
Cluster IP	10.10.0.25	Cluster management IP							
WebGUI	https://3.82.248.2:8443	URL for web GUI							
Node 1 Service IP	10.10.0.26	Node management IP							
Node 2 Service IP	10.10.0.27	Node management IP							

Figure 12 Cloud formation template output

IBM Spectrum Virtualize for Public Cloud cluster login and GUI access

Logging in to an IBM Spectrum Virtualize for Public Cloud cluster is almost the same process as logging in to a node. You replace the service IP with the cluster IP. Log in to the cluster with a GUI by using your browser, as shown in Figure 13.

	IBM.	
Sp	ectrum Virtualize for Public CI Storage Management (IBM-Spectrum-Virtualiz	oud ^{ie)}
	Username	
	Password	

Figure 13 IBM Spectrum Virtualize for Public Cloud on AWS login

With the GUI, you are guided through the steps that help you to complete your cluster installation.

Configuring back-end storage for IBM Spectrum Virtualize for Public Cloud

IBM Spectrum Virtualize for Public Cloud uses the back-end storage that is provided by AWS Cloud EBS Volume as an external MDisk.

To order back-end storage, log in to the AWS console:

1. Click Elastic Block Storage \rightarrow Volumes \rightarrow Create Volumes, as shown in Figure 14.

aws ser	vices	👻 Resource Group	ps v 1≽					L L L L L L L L L L L L L L L L L L L	¢	hemar
Bundle Tasks	•	Create Volume Acti	ions 👻							
ELASTIC BLOCK STORE Volumes	4	Q Filter by tags and attr	ributes or search by k	reyword						
Snapshots		Name	•	Volume ID	Ŧ	Size	*	Volume Type 👻	101	PS
Lifecycle Manager				vol-039542fe9893b9185		50 GiB		standard	-	
NETWORK & SECURITY				vol-046c2d3e4619f1f56		50 GiB		standard	-	
Security Groups				vol-05709b647b778ea3f		50 GiB		gp2	15	0
Elastic IPs				vol-092e8e901b62dfb48		8 GiB		standard	-	
Placement Groups				vol-0e8bd23e573fe2790		100 GiB		gp2	30	0

Figure 14 AWS Console with EBS volume details

2. Select the volume type and size of the volume required, as shown in Figure 15.

Volumes > Create Volume			
Volume Type	C Filter by attributes General Purpose SSD (gp2) Provisioned IOPS SSD (io1)		
Size (GiB)	Cold HDD (sc1) Throughput Optimized HDD (st1)	Max: 16384 GiB)	0
IOPS	Magnetic (standard) minimum of 3000 IOPS)	3 IOPS per GIB with a 100 IOPS, burstable to	0
Availability Zone*	eu-central-1a	• 0	
Throughput (MB/s)	Not applicable		
Snapshot ID	Select a snapshot	- C 0	
Encryption	Encrypt this volume		

Figure 15 EBS Create volume on AWS Console

The two volumes created and highlighted in red (as shown in Figure 14) are virtualized behind the IBM Spectrum Virtualize for Public Cloud on AWS.

As shown in Figure 16, two Pools are created on IBM Spectrum Virtualize for Public Cloud on AWS, and each Pool includes one assigned MDisk. The MDisk is the EBS external storage that was purchased on AWS Cloud.

To create a pool on IBM Spectrum Virtualize for Public Cloud on AWS:

1. Log in to IBM Spectrum Virtualize for Public Cloud and select **AWS GUI** → **Pools** → **Create Pool** (see Figure 16).

IBM	IBM Spectrum Virtualize for	Public	Cloud IBM-Spectrum-Virtualize Cloud Storage			💊 🗐 🕜
ᡎ			Create Pool Generate Pool Generate Pool Generate Pool Generate Pool			
~^		~	Name View All Throttles	State	Capacity	EBS Volume ID
æ	Deale		Unassigned If Customize Columns >			
ħ	PUUIS	Ť	V DR-Pool	✓ Online	50.00 GiB / 100.00 GiB (50%)	
0			mdisk1	✓ Online	100.00 GiB	vol-0e8bd23e573fe2790
8		~	V Pool0	✓ Online	18.00 GiB / 50.00 GiB (36%)	
			mdisk0	✓ Online	50.00 GiB	vol-05709b647b778ea3f
		ř				

Figure 16 Creating a Pool

2. After the Pool is created, click Action \rightarrow Discover storage, as shown in Figure 16.

The EBS volumes that are purchased on AWS Cloud and unused are visible under unassigned MDisk. To verify that the correct volume is added to the pool, check that the EBS Volume ID is the same volume ID as shown in the AWS Cloud console.

Add storage in the form of MDisk to the Pool.

Then, you can create a VDisk and assign the volume for host access that uses iSCSI.

Configuring site-to-site IPSec VPN for hybrid cloud connectivity

This section describes how to configure hybrid cloud connectivity between the AWS Cloud and the on-premises environment. This section also describes lab setup and the steps to configure the site-to-site IPSec tunnel for communication between AWS Cloud and the on-premises site.

Note: Although the logical steps for our use case is described in this section, the on-premises network configuration, infrastructure, and security policy can vary on a case-by-case basis. This section is intended to give a high-level logical example only.

The high-level architecture for hybrid cloud connectivity between on-premises and AWS cloud is shown in Figure 17 on page 15.



Figure 17 Hybrid cloud network connectivity topology between AWS cloud and on-premises

As shown in Figure 17, Virtual Private Cloud (VPC) in AWS is configured with a VPN gateway and router for the CIDR block 172.16.0.0/24. The VPN gateway is required for establishing the tunnel between the AWS cloud and the on-premises infrastructure. It acts as the default router for communication between AWS and on-premises systems. In AWS, all the compute hosts and IBM Software-defined storage systems are configured with IP addresses in the private IP subnet 172.16.1.0/24.

At the on-premises site, a network address translation (NAT) router is used (which is the core router) with a public IP address. That public IP address is NAT'ed to a private IP 10.1.210.9. The second router is a VyOS software gateway at the on-premises site that acts as a default gateway for a private subnet. The VyOS is used for the lab purpose to demonstrate that the PoC (in real-world organizations) can use their networking infrastructure.

The VPN IPSec site-to-site tunnel creates a secure communication network between the AWS Cloud infrastructure and the on-premises infrastructure. Network communication between the private subnets is controlled by the access control list that is populated when the VPN IPSec site-to-site tunnel is created.

AWS configuration for VPN IP Sec tunnel

This section describes the various steps that are required at the VPC level in AWS cloud for establishing the IP sec tunnel:

1. Create customer gateway.

Log in to the AWS console with the resource provisioning privileges and scroll down to the Virtual Private Network (VPN) section in the pane. Click **Customer Gateways** and enter the required information, as shown in Figure 18.

Customer Gateways > Create Customer	Customer Gateways > Create Customer Gateway			
Create Customer Gat	teway			
Specify the Internet-routable IP address for also specify your gateway's Border Gatew	r your gateway's external interface; the address must be ay Protocol (BGP) Autonomous System Number (ASN);	static and may be behind a device performing network address transla this can be either a public or private ASN (such as those in the 64512-	ation (NAT). For dynamic routing, 65534 range).	
Name	onpremise-GW1	0		
Routing	DynamicStatic			
IP Address*	192.109.81.204	0		
* Required		Cance	Create Customer Gateway	

Figure 18 Customer gateway configuration in AWS

2. Create Virtual Private Gateways.

Click the **Virtual Private Gateways** section in the VPC and configure the required information, as shown in Figure 19.

Virtual Private Gateways > Create Virtual	Virtual Private Gateways > Create Virtual Private Gateway			
Create Virtual Private	Gateway			
A virtual private gateway is the router on th	e Amazon side of the VPN tunnel.			
Name tag	hybrid multicloud gateway	0		
ASN	Amazon default ASN Custom ASN			
* Required			Cancel Create Virtual Private Gateway	

Figure 19 Virtual private gateway configuration in AWS

3. Attach the Virtual Private Gateway to the VPC, as shown in Figure 20.

Virtual Private Gateways > Attach to VPC				
Attach to VPC	Attach to VPC			
Select the VPC to attach to the virtual priva	te gateway.			
Virtual Private Gateway Id	vgw-0d3769b845efa561d			
VPC*	vpc-01b400ec53542b784	C		
* Required			Cancel Yes, Attach	

Figure 20 Attaching Virtual private gateway to VPC in AWS

4. Create Site-to-Site VPN connection in AWS console, as show in Figure 21.

VPN Connections > Create VPN Connect	ion		
Create VPN Connect	on		
Select the virtual private gateway and cust	omer gateway that you would like to connect via	a VPN co	onnection. You must have entered the vi
Name tag	VPN to Germany		0
Virtual Private Gateway	vgw-071860227e2c36fb6	•	C
Customer Gateway	 Existing New 		
Customer Gateway ID	cgw-08b9661d8bf74246e	•	C
Routing Options	Dynamic (requires BGP)Static		

Figure 21 Creating VPN connection in AWS

5. Select the Virtual Private Gateway and the Customer Gateway parameters that were created (as shown in Figure 19 on page 16 and Figure 20 on page 16).

Two tunnels in the VPC are created in these steps and the same is used for the configuration at the other end of the tunnel.

Configuring the VYOS router at on-premises

Complete the following steps to configure the VYOS router at on-premises location:

1. Enable NAT-T.

The address of the external interface for your customer gateway must be a static address. In the LAB configuration, we used the VYOS gateway that is behind a device that is performing network address translation (NAT). To ensure that NAT traversal (NAT-T) can function, you must adjust your firewall rules to unblock UDP port 4500:

set security vpn ipsec nat-traversal enable

2. IPSec tunnel #1 configuration:

a. Internet Key Exchange (IKE) configuration:

```
set vpn ipsec ike-group AWS lifetime '28800'
set vpn ipsec ike-group AWS proposal 1 dh-group '2'
set vpn ipsec ike-group AWS proposal 1 encryption 'aes128'
set vpn ipsec ike-group AWS proposal 1 hash 'sha1'
set vpn ipsec site-to-site peer 1.1.1.1 authentication mode
'pre-shared-secret'
set vpn ipsec site-to-site peer 1.1.1.1 authentication pre-shared-secret
'mD2U0cZmKY23sX30u.Iox_OFj_GYcsEd'
```

set vpn ipsec site-to-site peer 1.1.1.1 description 'VPC tunnel 1'
set vpn ipsec site-to-site peer 1.1.1.1 ike-group 'AWS'
set vpn ipsec site-to-site peer 1.1.1.1 local-address '192.109.81.204'
set vpn ipsec site-to-site peer 1.1.1.1 vti bind 'vti0'
set vpn ipsec site-to-site peer 1.1.1.1 vti esp-group 'AWS'

b. Encapsulating Security Payload (ESP) configuration:

set vpn ipsec ipsec-interfaces interface 'eth0'
set vpn ipsec esp-group AWS compression 'disable'
set vpn ipsec esp-group AWS lifetime '3600'
set vpn ipsec esp-group AWS mode 'tunnel'
set vpn ipsec esp-group AWS pfs 'enable'
set vpn ipsec esp-group AWS proposal 1 encryption 'aes128'
set vpn ipsec esp-group AWS proposal 1 hash 'sha1'

c. Configure IPSec dead peer detection parameters:

set vpn ipsec ike-group AWS dead-peer-detection action 'restart' set vpn ipsec ike-group AWS dead-peer-detection interval '15' set vpn ipsec ike-group AWS dead-peer-detection timeout '30'

d. Configure IPSec tunnel parameters:

set interfaces vti vti0 address '169.254.40.102/30'
set interfaces vti vti0 description 'VPC tunnel 1'
set interfaces vti vti0 mtu '1436'

e. Border Gateway Protocol (BGP) configuration:

BGP is used within the tunnel to exchange prefixes between the Virtual Private Gateway and your Customer Gateway. The Virtual Private Gateway announces the prefix corresponding to your VPC:

set protocols bgp 65000 neighbor 2.2.2.2 remote-as '64512' set protocols bgp 65000 neighbor 2.2.2.2 soft-reconfiguration 'inbound' set protocols bgp 65000 neighbor 2.2.2.2 timers holdtime '30' set protocols bgp 65000 neighbor 2.2.2.2 timers keepalive '10'

Note: Your Customer Gateway might announce a default route (0.0.0.0/0). If needed, the route can be configured with the *network* statement, as shown in the following example:

set protocols bgp 65000 network 0.0.0/0

To advertise more prefixes to the Amazon VPC, replace the 0.0.0.0/0 with the prefix that you want to advertise. Ensure that the prefix is present in the routing table of the device with a valid next-hop.

- Configure IPSec tunnel #2. Repeat steps 1 and 2 on page 17 for the tunnel #2 IP address, and then complete the following steps:
 - a. Configure IKE parameters:

set vpn ipsec ike-group AWS lifetime '28800'
set vpn ipsec ike-group AWS proposal 1 dh-group '2'
set vpn ipsec ike-group AWS proposal 1 encryption 'aes128'
set vpn ipsec ike-group AWS proposal 1 hash 'sha1'
set vpn ipsec site-to-site peer 3.3.3.3 authentication mode
'pre-shared-secret'

set vpn ipsec site-to-site peer 3.3.3.3 authentication pre-shared-secret '63VRY4qF.6viqkguHB8wOwQKOFJdsvk1' set vpn ipsec site-to-site peer 3.3.3.3 description 'VPC tunnel 2' set vpn ipsec site-to-site peer 3.3.3.3 ike-group 'AWS' set vpn ipsec site-to-site peer 3.3.3.3 local-address '192.109.81.204' set vpn ipsec site-to-site peer 3.3.3.3 vti bind 'vti1' set vpn ipsec site-to-site peer 3.3.3.3 vti esp-group 'AWS'

b. Tunnel Interface configuration:

set interfaces vti vtil address '169.254.42.106/30'
set interfaces vti vtil description 'VPC tunnel 2'
set interfaces vti vtil mtu '1436'

c. Border Gateway Protocol (BGP) configuration:

set protocols bgp 65000 neighbor 169.254.42.105 remote-as '64512'
set protocols bgp 65000 neighbor 169.254.42.105 soft-reconfiguration
'inbound'
set protocols bgp 65000 neighbor 169.254.42.105 timers holdtime '30'
set protocols bgp 65000 neighbor 169.254.42.105 timers keepalive '10'

4. Check the tunnel status.

On the VYOS router, the VPN IPSec tunnel status can be verified by running the following command (as shown in Figure 22):

show vpn ipsec sa

vyo	s@VyOS−c	lass24:	~\$ show vpn ips	ec sa					
Pee	r ID / I	P		Lo	cal ID	/ IP			
18.	196.141.	88		10	.1.240.	9			
	Descrip	tion: V	PC tunnel 3						
	Tunnel	State	Bytes Out/In	Encrypt	Hash	NAT-T	A-Time	L-Time	Proto
	vti	up	2.3K/2.8K	aes128	shal	yes	1208	3600	all
Pee	r ID / I	P		Lo	cal ID	/ IP			
35.	158.164.	103		10	.1.240.	9			
	Descrip	tion: V	YPC tunnel 4						
	Tunnel	State	Bytes Out/In	Encrypt	Hash	NAT-T	A-Time	L-Time	Proto
	vti	up	221.3M/125.8M	aes128	sha1	yes	3462	3600	all

Figure 22 Checking VPN IPSec status at VYOS router

You can also check the status at the VPC AWS console by selecting **Site-To-Site Connections** \rightarrow **Tunnel Details** (see Figure 23).

Name VF	PN ID	State -	Virtual Private Gateway	- Transit Gateway
Kelsterbach vp	n-00a71e802a290e3b2	available	vgw-071860227e2c36fb6 cactus private gat	
<			000	
VPN Connection: vpn-00a	71e802a290e3b2			
Details Tunnel Detai	Is Tags			
Outside IP Address	Inside IP CIDR	Status	Status Last Changed	Details
18.196.141.88	169.254.40.100/30	UP	April 3, 2019 at 11:06:18 AM UTC+5:30	1 BGP ROUTES
35.158.164.103	169.254.42.104/30	UP	April 3, 2019 at 11:06:29 AM UTC+5:30	1 BGP ROUTES

Figure 23 Checking VPN IPSec status from AWS console

Configuring IBM Spectrum Connect

IBM Spectrum Connect is a centralized cloud integration system that consolidates a range of IBM storage provisioning, virtualization, cloud, automation, and monitoring solutions through a unified server platform.

IBM Spectrum Connect provides a single-server back-end location and enables centralized management of IBM storage resources for different virtualization and cloud platforms.

Through its user credential, storage system, storage space, and service management options, IBM Spectrum Connect facilitates the integration of IBM storage system resources with the supported virtualization and cloud platforms, while providing the foundation for integration with future IBM systems and independent software vendor (ISV) solutions.

IBM Spectrum Connect can be managed through a standard web browser and a graphical user interface (GUI), or through terminal and a command-line interface (CLI).

This section provides the steps to perform several configurations to deliver storage as a service in IBM Spectrum Connect. However, the installation process is as per the official installation guidelines of Spectrum Connect 3.6.0

Storage space and service management

After deployment and storage system attachment, the IBM Spectrum Connect administrators must define the new virtual entities, which results in simpler and more flexible storage management. The virtual storage entities include the following components:

- Storage service: A combination of assigned storage resources (pools) and user-defined policies (capabilities). The storage resources that are assigned to the service can be on any storage system. The policies are extra capabilities, or storage requirements for the service, including compression and encryption.
- Storage space: A logical grouping of several storage services. Usually, a single space is assigned to a specific organization (storage tenant). Such systems hold a storage resource (IBM FlashSystem group pool) that is connected to the service.

Therefore, in addition to its set of attributes (compression, encryption, and so on), each service receives a user-defined storage capacity.

As a best practice, you define storage space as departments of organization and each organization can have its naming conventions, such as gold and silver (where gold service defines on-premises, silver services for cloud, and so on).

The combination of storage space and service is created by storage administrators to include the required resource capacity and storage capabilities on a matching storage system.

IBM FlashSystem storage system added in IBM Spectrum Connect

Use the format https://[Spectrum Connect IP address]:8440 to log in and add the IBM FlashSystem system and IBM Spectrum Virtualize for Public Cloud.

The IBM Spectrum Connect GUI provides an intuitive easy-to-use browser-based interface for managing IBM storage resources. The IBM Spectrum Connect GUI consists of the following panes:

- Interfaces: Integration with vCenter Orchestrator and vRealize Orchestrator servers
- Spaces/Storage Services: Handling storage spaces and services
- Storage Systems: Management of storage systems and storage resources
- Monitoring: Integration with vRealize Operations Manager server

IBM Spectrum Connect Dashboard

After successfully logging in, the Default_Space/Storage Services and Storage Systems panes are displayed, as shown in Figure 24.



Figure 24 IBM Spectrum Connect Dashboard

IBM Spectrum Connect GUI: Entering the storage system credentials

Spectrum Control Base can use only a single system management account for accessing all of the different storage systems that you use. For storage systems running Spectrum Virtualize, ensure that the credentials belong to a user account with the VASA Provider role. Complete the following steps to enter the storage system credentials:

1. Click **Settings** and then, click **Storage credentials** from the Settings menu, as shown in Figure 25.



Figure 25 IBM Spectrum Connect settings menu

- 2. Enter the user name and password of the storage admin user that was defined on all of your IBM storage systems.
- If the storage admin user account is defined on a directory server, select the Directory account option. If the storage admin user account is locally defined on the storage system, clear the check box.
- 4. Click Apply.

Setting the storage credentials on Spectrum Connect allows you to add and manage the IBM storage systems in the section.

IBM Spectrum Connect GUI: Managing storage systems

All IBM storage systems that provide storage resources must be defined as storage systems on IBM Spectrum Connect. You must add a storage system to access the storage system management options. To do so, use the Add a storage system wizard and complete the following steps:

- Image: With Storage Services
 Image: Storage Services

 Image: With Storage Services
 Image: Storage Service

 Image: With Storage Service
 Image: Storage Service

 <t
- 1. Click the (+) in the upper right and select Add a storage system (see Figure 26).

Figure 26 IBM Spectrum Connect adding storage system wizard

 After adding the storage system, you can find the system in Storage Systems pane (see Figure 27).



Figure 27 IBM Spectrum Connect Storage system pane

3. Create a pool in IBM FlashSystem and IBM Spectrum Virtualize for Public Cloud running in AWS Cloud. Then, in IBM Spectrum Connect, create storage space and storage service, as shown in Figure 28. Create two services: one for On-premise and another one for Cloud storage. Map it with the vRO interface, as shown in Figure 28.



Figure 28 Attaching the storage service with the storage resource

VMware vRealize Orchestrator configuration

Install vRealize Orchestrator appliance. For more information about VMware vRealize Orchestrator installation, see this website.

After completing the activities mentioned earlier in section "IBM Spectrum Connect GUI: Managing storage systems" on page 22, click **Add Interface** and complete the following steps to configure VMware vRealize Orchestrator:

1. Add the VMware vRealize Orchestrator (vRO) details in the Interfaces Pane, as shown in Figure 29.

Interfaces			Add Interfac
vRO I Allocated 2.1TiB (Used 48%)			
	vRO Settings 🚯	×	
	Current vRO token	Regenerate	
	6b0a4518298f7dd2f4984856	48c0991978f5c942	
	💆 Download plug-in packag	je i	
	Remove	Cancel Apply	

Figure 29 vRO download plug-in

- 2. In the Interfaces pane, right-click **vRO server** and then, click **Modify**. The vRO Settings dialog box is displayed.
- 3. At the bottom of the dialog box, click **Download plug-in package**.

Note: Add the Download plug-in package (from step 3) to vRealize Orchestrator after the VMware vRealize Orchestrator configuration (during step 7 on page 24).

- 4. Copy the current vRO token key from the Current vRO Token box.
- 5. Start the VMware vRealize Orchestrator configuration interface.
- 6. On the Certificate tab, click **Trusted Certificates** and then, import the Spectrum Control Base certificate. The certificate URL format is: https://IP_address:TCP port in use.
- 7. On the Plug-ins tab, click **Manage Plug-ins** → **Install New Plug-in**. Then, click **Browse** and choose the downloaded plug-in file. Click **Install**. Accept the license agreement. The message, IBM Storage (3.4.0.x) New plug-in installed, is displayed. Installation is completed, and the IBM Storage plug-in is displayed in the list of vRO plug-ins on VMware vRealize Orchestrator Control Center (see Figure 30).

vm	VMware vRealize Orchestrator			
	AW\$ 1.0.0.5102111 Amazon AW\$ plug-in for vCenter Orchestrator 🚣	DEFAULT	~	
-	Configurator 7.5 0.10044239 Configuration plug-in for vRealize Orchestrator 📥	DEFAULT	~	
Ð	DynamicTypes 13.18279503 Dynamic Types plug-in for vRealize Orchestrator 📥	DEFAULT	~	
	Enums 7.01.4939616 Common enumerated types 📥	Select	~	
1214	IBMStorage 3.4.0.533 IBM Storage Plug-in. ▲	DEFAULT	~	
a	Likear 7.014020516			

Figure 30 Successful installation of IBM Storage Plug-in in VMware vRealize Orchestrator

Note: The token that is generated or copied in Spectrum Control Base is entered in the vRO configuration.

- 8. In the Startup Options pane, click **Restart** to restart the vRO server service.
- 9. Start the VMware vRealize Orchestrator client and click the Workflows tab.
- 10.Click Library → IBM Storage → Configuration Select and run the Set Server and Token workflow. Click Submit after entering information (see Figure 31).

Ũ	Start Workflow : Set Server and Token
Common parameters	Start Worknow : Set Server and Token * server * port 8440 * token
	Cancel Submit

Figure 31 Start Workflow: Set Server and Token dialog box

Notice that the Start Workflow: Set Server and Token dialog box is displayed (see Figure 32).



Figure 32 VMware vRealize Orchestrator Set Server and Token workflow output

VMware vRealize Automation

VMware vRealize Automation automates the delivery of personalized infrastructure, applications, and custom IT services. vRealize Automation provides a secure portal in which authorized administrators, developers, or business users can request new IT services and manage specific cloud and IT resources, while ensuring compliance with business policies.

Requests for IT service (including infrastructure, applications, and desktops) are processed through a unified IT service catalog to provide a consistent user experience across a multivendor, hybrid cloud infrastructure.

vRealize Automation simplifies application release and provides continuous delivery with the use of vRealize Code Stream. It streamlines the design process by assembling applications from pre-built components by using a visual canvas with a drag-and-drop interface, accelerates workload deployment by using a library of immediately available content, and supports configuration management tools, such as Chef and Puppet.

vRealize Automation includes the following features and capabilities:

- Infrastructure as a service
- Self-service with unified service catalog and API functionality
- Unified Blueprint model and Advanced Service Designer
- Automate the delivery of any IT services
- IT Business Management Standard Edition
- · Multi-vendor virtual, physical, and public cloud support
- XaaS

This section, section "XaaS" on page 26 and section "Service catalog" on page 26 provide an overview for providing on-demand service to users, XaaS, service catalog, and Advanced Service Designer. For more information in these areas, see this website.

XaaS

The XaaS architects can create XaaS Blueprints and resource action and publish them as catalog items. With XaaS, you can provide anything as a service by using the capabilities of VMware vRealize Orchestrator.

For example, you can create a blueprint that allows a user to request a backup of a database. After completing and submitting a backup request, the user receives a backup file of the database they specified.

A XaaS architect can create custom resource types that are mapped to vRealize Orchestrator object types and define them as items to be provisioned. A XaaS architect can then create blueprints from vRealize Orchestrator workflows and publish the blueprints as catalog items.

The vRealize Orchestrator workflows can be predefined or independently developed by workflow developers. You can also use the XaaS to design more actions that the consumer can perform on the provisioned items. These other actions are connected to vRealize Orchestrator workflows and take the provisioned item as input to the workflow. To use this function for items that are provisioned by sources other than the XaaS, you must create resource mappings to define their resource types in vRealize Orchestrator.

Service catalog

The service catalog provides a unified self-service portal for consuming IT services. Service catalog administrators can manage user access to catalog services, items, and actions by using entitlements and approvals. Users can browse the catalog to request items that they need, track their requests, and manage their provisioned items.

Service architects and administrators can define new services and publish them to the common catalog. When defining a service, the architect can specify the kind of item that can be requested, and what options are available to the consumer as part of submitting the request.

Group managers or line-of-business administrators can specify business policies, such as who is entitled to request specific catalog items or perform specific actions on provisioned items. They can also apply configurable approval policies to catalog requests.

Users who are responsible for managing the catalog (such as tenant administrators and service architects) can manage the presentation of catalog items to the consumers of IT services; for example, by grouping items into service categories for easier navigation and highlighting new services to consumers on the portal home page.

For more information about installing vRealize Automation, see this web page.

VMware vRealize Automation configuration

This section provides the steps to perform several configurations for delivering storage as a service in vRealize Automation.

To get started, complete the following steps:

1. Log in to vRealize Automation using the user name: configurationadmin,

2. To create advanced services and publish them, roles must be assigned. A user must have the roles of IaaS administrator (by default), Tenant administrator, Service Architect, XaaS Architect, and Infrastructure Architect.

In the following example and steps, the test team assigned the Service Architect role to the group, Domain Admin. The Domain Admin group has configurationadmin@vsphere.local as a member. Complete the following steps:

1. Click Administration → Directory Users & Groups. Next, click the Search tab. Then, select the user (in this case, select configurationadmin), as shown in Figure 33.

vm ware [,] vRealize		nation	Q (2)
Catalog Deployments	Design	Inbox Administration Infrastructure Containers	
Approval Policies Directories Management	vercories Management > You can view the Directory users and groups information.		
Users & Groups	~	Name Description A admin admin (configurationadmin@vsphere.local) admin admin	Email configurationadminititest.com
Custom Groups			
Catalog Management	>		

Figure 33 Directory Users and Group

 Assign a role to the user (configurationadmin). Select the Tenant Administrator, XaaS Architect, Software Architect (optional), Infrastructure Architect options to specify the roles (see Figure 34).

vm ware vRealize		omation				
Catalog Deployments	Design	Inbox Administration	Infrastructure Containers			
Approval Policies		User Details: admin ad	imin			
Directories Management	>	General Directory Groups	Custom Groups Business Groups Entitled Items	S		
Users & Groups	~					
Directory Lisers and Groups		First name:	admin	Add roles to this User.		
Directory Osers and Groups		Last name:	admin	Application Architect		
Custom Groups		Look Hurre.		Approval Administrator		
Business Groups		Email:	configurationadmin@test.com	Catalog Administrator		
Catalog Management	>	User name:	configurationadmin@vsphere.local	Container Architect		¥
Property Dictionary	>	Domain:	vsphere.local	Authorities Granted by Selected Roles.		
Bard an atlan		Tenant:	vsphere.local	Access UI		^
Reclamation	>			Access my tenant administration GUL		=
Branding	>			Access my tenant directories, groups and users admini	tration GUIs	
				transporter the laboration and laboration ensurement dealers t		

Figure 34 Edit user details

 Log in and log out of the vRealize Automation web console to reflect the changes. Click the **Design** tab (as shown in Figure 36 on page 28) to create XaaS services and blueprints.

Creating XaaS service category

The service catalog provides a common interface for consumers of IT services to use for requesting and managing the services and resources they need. Service categories organize catalog items into related offerings to make it easier for users to browse for the catalog items they need. Use the following example steps to create a service category and service:

Click Administration → Catalog Management → Services. Then, click +New to create a service.

2. For the new service, enter the name: IBM Storage. Select status as **Active** to make it immediately available (see Figure 35).

vmw	a re vRealize		mation								
Catalog	Deployments	Design	Inbox	Administration	Infrastructure	Containers					
Approval I	Policies		Services								Sea
Directorie	s Management	>	A New	View Details	copy 🗶 Delete	Activate					
Users & Gi	roups	>	Name +		Status		Description	Last Updated On	Las	t Updated	Ву
Catalog M	lanagement	~	IBM Storage		Active			3/19/19, 9:32 PM	adn	nin admin	
Services			vRA Configura	ition	Active		Infrastructure endpoint configuration service	3/15/19, 3:21 AM	adn	nin admin	
Catalog Ite	ems										

Figure 35 Add a new service and list

Create a custom resource

Perform the following example steps to create a custom resource:

 Open vRealize Automation and click Design → XaaS → Custom Resource. Then, click New (see Figure 36).

vm ware [,] vRealize	e Auto	omation			
Catalog Deployments	Design	Inbox Administration	Infrastructure Cor	ntainers	
Blueprints		Custom Resources	irces to provision by using V	225 bluervinte	
XaaS	~	A New Codit	arees to provision by using A	aas blacprints.	
Custom Resources		Name		Туре	
Resource Mappings		Azure Virtual Machine		Azure:VirtualMachine	
		IBM Storage		IBMStorage:StorageVolume	
XaaS Blueprints					
Resource Actions					

Figure 36 Custom Resource

- On the Resource type tab, you must select an orchestrator type and add the resource name and description. Specify the Orchestrator type as: IBMStorage:StorageVolume. Then, add the name and details. In this example, the name is entered as IBM storage.
- 3. Retain the default settings on the Details Form page. Click Finish.

Creating XaaS Blueprints

A XaaS Blueprint is a complete specification of a service. With XaaS Blueprints, you can publish predefined and custom vRealize Orchestrator workflows as catalog items. You can also optionally map a workflow output parameter to a custom resource to define the item to be provisioned.

This section describes the creation of a XaaS Blueprint, which creates an IBM storage volume as an output resource. It further describes adding resource actions to the output or provisioned resource and publishing those to the service catalog. The resource actions are the additional services that can be performed on the provisioned resource from this XaaS Blueprint.

Perform the following steps to create a new XaaS Blueprint:

- 1. Click **Design** \rightarrow **XaaS Blueprints** and then click +New.
- The default folder is displayed. The default folder is the Orchestrator workflow library from where the required workflow can be selected. The external or embedded vRealize Orchestrator is already configured with vRealize Automation.
- 3. To select the Create a Volume workflow, click **Orchestrator** → **IBM** > **Storage** → **Create** and **Map a Volume** (see Figure 37).



Figure 37 Adding XaaS blueprint and selecting the workflow for the blueprint

4. On the right side of the window, the details of the workflow (such as input and output parameters) is displayed. Click **Next** (see Figure 38).

New Blueprint			
Select a workflow:	ę	Selected workflow:	
Grichestrator Grichestrator Gibrary GAmazon Web Services GAmazon Web Services	^	Name: Description: Input parameters:	Create and Map a Volume Creates a volume in the designated storage service, and maps the volume to hosts or clusters.
Configuration Confi	=	Name service name size initiators	Type IBMStorage:StorageService string number Array/string slaving 1 - 4 of 4
Conguration Copy of Create and Map a Volume Create and Map a Volume		Output parameters:	
Colete a Volume Colete a Volu		newVolume	1 ype IBMStorage:StorageVolume playing 1 - 1 of 1

Figure 38 Blueprint name

5. Enter: Create and Map a Volume in the Name field and add details in the Description field. Then, click **Next**. 6. In the Blueprint form, you can specify the values according to workflow. In this example, the constant values of the initiators are mentioned. Click **Next** (see Figure 39).



Figure 39 Blueprint form

You can see a service blueprint: Create and Map an IBM Storage Volume (for Cloud and on premise), as shown in Figure 40.

Catalog Deployments	Design	Inbox	Administration	Infrastructure	Containers		
Blueprints		XaaS Blu	eprints				
XaaS	~	Create and m	anage Xaas blueprin	s and publish them a	s catalog items	. You can select a workflow, define the forms associated with the catal	og item, and select
Custom Resources	Ourtern Deseurces → New / Edit 🔯 Copy 🕢 Publish 🕐 Unpublish 🗮 🗙 Delete						
custom Resources		Name 🔺				Description	Status
Resource Mappings		Azure Machin	ne			Creates new Azure virtual machine	Published
		Create and M	lap a Volume - Cloud			Creates a volume in the designated storage service, and maps the volume to	Published
XaaS Blueprints		Create and M	lap a Volume _ Onpren	ise		Creates a volume in the designated storage service, and maps the volume t	Published
Descurse Actions		vSphere Initia	al Setup			Publish VRA Catalog items based on vSphere endpoint virtual machine temp	Published
Resource Actions							

Figure 40 List of XaaS Blueprints

7. Blueprints must be published to appear in the service catalog. Select the service Blueprint and click **Publish**.

At this point, the XaaS Blueprint should be available as a catalog item on the Administration tab, as shown in Figure 41.

Catalog	Deployments	Design	Inbox	Administration	Infrastructure	Containers				
Approval I	Policies		Catalog I	tems						
Directorie	s Management	>	Catalog item: available in th	s are published bluep ne service catalog, ad	rints, XaaS blueprints, d the item to a service	and software compone and then entitle the ca	ts. These blueprints and c alog item to a business gr	omponents are publishe oup. Software compone	d on the Design tab or using t nts can also be entitled to enfo	he vRealize Automation prce approval policies, bi
Users & G	roups	>	Advanced Search							
Catalog M	lanagement	~	View Det	ails 🕟 Activate						
Services			Name 🔺		Status	Source	Resource Type	Scope	Appears in Catalog	Service
			Create and M	lap a Volume - Cloud	Published	XaaS	IBM Storage	Shared	Yes	IBM Storage
Catalog Ite	ems		Create and N	lap a Volume _ Onpren	nise Published	XaaS	IBM Storage	Shared	Yes	IBM Storage
			Docker - Con	eOS	Published	Blueprint Serv	ce Deployment	Shared	Yes	
Actions			Docker - Pho	tonOS	Published	Blueprint Serv	ce Deployment	Shared	Yes	
Entitlemen	nts		vSphere Initia	al Setup	Published	XaaS		Shared	Yes	vRA Configuration

Figure 41 Catalog items

 Click Administration → Catalog Management → Catalog Items. In the Configuring catalog items section, provide the steps to configure the catalog item. 9. Attach a storage service by selecting **IBM Storage as a service** from the drop-down menu. You can then see the service attached.

Creating a resource action

This section provides the steps to create resource actions for an item or an output resource that is provisioned as a result of running a catalog item.

Complete the following steps:

1. Click **Design** \rightarrow **XaaS** \rightarrow **Resource Actions** and then click **New** (see Figure 42).

vm ware vRealize	Autor	mation				Q
Catalog Deployments	Design	Inbox Adm	inistration Infrastructu	e Containers		
Blueprints XaaS Custom Resources	~	Resource Acti Create and manage Advanced Search	ions custom resource actions to de Copy O Publish O Ung	line the operations that can be performed on the prov	isioned items.	
Resource Mappings		Name		Description	Resource +	Status
XaaS Blueprints		Map a Volume Unmap a Volume		Maps the volume to hosts or clusters. Unmaps the volume from the hosts or clusters to which	IBM Storage it IBM Storage	Published
Resource Actions		Delete a Volume		Deletes the volume from the storage service.	IBM Storage	Published
		Chart		Downee on the enceified Amore virtual machine	Amon Metual Machina	Dublichad

Figure 42 Resource Actions

 Browse to the workflow that you want to define as a resource action to an item that will be provisioned by the workflow (added in the previously created XaaS Blueprint). Click Create and Map a Volume workflow and click Next, as shown in Figure 43.

Catalog Deployments	Design	Inbox Administration Infrastructure Containers								
Blueprints		New Resource Action								
XaaS	~	Workflow Input Resource Details Form								
Custom Resources		Select a workflow: Selected workflow:								
Resource Mappings XaaS Blueprints				Name: Create and Map a Volume Description: Creates a volume in the designated storage service, and maps the volume to hosts or clusters. Input parameters:						
Resource Actions		G AMQP Samples G Configuration		Name Type		Туре				
		▷ 💋 Dynamic Types ▷ 💋 HTTP-REST	=	name	ice ie	IBMStorage:StorageService string				
		HTTP-REST Samples		size initiators		number Array/string				
		↓ Storage ↓ Configuration		0utou	↓ ▷ ▷ Displaying 1 - 4 of 4					
		Copy of Create and Map a Volume		Jacpu	n perentereta.	-				
		Control of a volume Control		new/	ne Volume ∢	Type IBMStorage:StorageVolume				

Figure 43 Resource Actions

 As shown in Figure 44, on the Input Resource tab, select the resource type as IBM volume (defined as a custom resource) and select volume as the input parameter. Click Next.

Catalog Deployments	Desigr	Inbox Administration Infra	tructure Containers		
Blueprints		New Resource Action			
XaaS	~	Workflow Input Resource Details	Form		
Custom Resources		Select a valid input resource type for this	Catalog Deployments	Design	Inbox Administration Infrastructure Containers
Resource Mappings		Resource type: IBM St	Blueprints		Map a Volume - New Resource Action
XaaS Blueprints		Input parameter: volume	XaaS	~	Workflow Input Resource Details Form
Resource Actions		Mapped to Orchestrator type: IBMSto	ge Custom Resources		*Name: Map a Volume
		Description:	Resource Mappings		Description: Maps the volume to hosts or clusters.
			XaaS Blueprints		
			Resource Actions		Hide catalog request information page
					Version:
					Type
					Target criteria: ● ● Aways available ● ○ Available based on conditions

Figure 44 Input Resource Actions details

- 4. On the Details tab, enter Map a Volume in the Name field and click Next.
- 5. On the Form tab, change the label *initiator* by hovering the mouse pointer to the right of text box and click the **highlighted form** that appear. You can add the details, as shown in Figure 45.

Catalog Deployments	Design Inbox Administration Infrastructure Containers	
Blueprints	Map a Volume - New Resource Action	
XaaS	Workflow Input Resource Details Form	
Custom Resources	Form: Action form 🗸 🥖 🗙 💠 😂	
Resource Mappings		
XaaS Blueprints	New fields	
Resource Actions	ABC Text field The host initiators to which the volume c	
	ABC Text area No data selected	
	http:// Link	
	🖻 Email	
	**** Password herd	

Figure 45 Resource Actions form design

- 6. Click **Finish** to complete the step. It is in Draft status. Select the resource action and publish it.
- 7. Similarly, you can create resource actions for the following services by using the available IBM storage workflows:
 - Map a Volume
 - Nmap a Volume
 - Extend a Volume
 - Delete a Volume

Configuring catalog items

In this section, you can overview the steps needed to configure the blueprint as a catalog item. The XaaS Blueprint: Create an IBM Storage Volume created in section "Creating XaaS Blueprints" on page 28, is listed as a catalog item.

Select Administration \rightarrow Catalog Management \rightarrow Catalog Items, as shown in Figure 46.

Advanced Search				requested as part of a blueprint. If you unpublish a catalog item, it will no longer be available in the service catalog.								
		Advanced Search										
Configure Deactivate												
Name 🔶	Status	Source	Resource Type	Scope	Appears in Catalog	Service						
Create and Map a Volume - Cloud	Published	XaaS	IBM Storage	Shared	Yes	IBM Storage						
Create and Map a Volume _ Onpremise	Published	XaaS	IBM Storage	Shared	Yes	IBM Storage						
Docker - CoreOS	Published	Blueprint Service	Deployment	Shared	Yes							
Docker - PhotonOS	Published	Blueprint Service	Deployment	Shared	Yes							
vSphere Initial Setup	Published	XaaS		Shared	Yes	vRA Configuration						
	Name + Create and Map a Volume - Cloud Create and Map a Volume _ Onpremise Docker - CoreOS Docker - PhotonOS vSphere Initial Setup	Name • Status Create and Map a Volume - Cloud Published Create and Map a Volume - Onpremise Published Docker - CoreOS Published Docker - PhotonOS Published VSphere Initial Setup Published	Name * Status Source Create and Map a Volume - Cloud Published Xaa5 Create and Map a Volume - Compremise Published Xaa5 Docker - CoreOS Published Bueprint Service Docker - PhotonOS Published Bueprint Service VSphere Initial Setup Published Xaa5	Name * Status Source Resource Type Create and Map a Volume - Cloud Published XaaS IBM Storage Create and Map a Volume - Cloud Published XaaS IBM Storage Docker - CoreOS Published Biospint Service Deployment Docker - PhotonOS Published Biospint Service Deployment Vsphere Initial Setup Published XaaS	Name ^ Status Source Resource Type Scope Create and Map a Volume - Could Published XaaS IBM Storage Shared Create and Map a Volume - Course Published XaaS IBM Storage Shared Docker - CoreOS Published Blueprint Service Deployment Shared Docker - MotionOS Published Blueprint Service Deployment Shared Visphere Initial Setup Published XaaS Shared Shared	Name ^ Status Source Resource Type Scope Appears in Catalog Create and Map a Volume - Could Published XaaS IBM Storage Shared Yes Create and Map a Volume - Cource Published XaaS IBM Storage Shared Yes Docker - CoreCoS Published Blueprint Service Deployment Shared Yes Docker - MotionOS Published Blueprint Service Deployment Shared Yes Visphere Initial Setup Published XaaS Shared Yes						

Figure 46 List Catalog items

You need to configure this catalog item with more information, such as the service category to which it should be added. To configure the catalog item, select the item and click **Configure**.

Within the Configure Catalog Item window, you can add the description for the catalog item, provide an icon, keep the status as active or inactive, and most importantly, add this catalog item under a pre-configured service category.

As shown in Figure 47, you can add it under IBM Storage service and keep the other details as is. Click **Update**.

Configure Catalog General Entitlements	Item				
Name: Source: Resource type:	Create and Map a Volume XaaS IBM Storage	_ Onpremise			
Description:	Creates a volume in the designated storage service, and maps the volume to hosts or clusters.				
lcon:	Browse Recommended size: 100 x 100 pixels				
Preview	Elst view Catalog v	iew Detail view Detail view IBM Spectrum Virtualize			
Status:	Active	٧			
Quota:	Unlimited	* *			
Service:	IBM Storage	¥			
OK CANCEL					

Figure 47 Configure Catalog items

Creating entitlement

In this section, we describe how to configure an entitlement. Entitlement provides access for the user (configurationadmin) to a service, catalog items, and a set of actions.

Complete the following example steps:

- Click Administration → Catalog Management → Entitlements. Then, click Add to create an entitlement (see Figure 48).
- Enter the name for an entitlement and select the user, or group, or both that will be part of this entitlement. As shown in Figure 48, IBM Storage Entitlement is the name entered for a new entitlement with configurationadmin as the user.

You can add services, catalog items, and actions under the entitlement.

Approval Policies		Edit Entitlement						
Directories Management	>	General Items & Approval	S					
Users & Groups	>					* Users & Groups:		
Catalog Management	\sim	*Name:	*Name: IBM Storage Entitlement		All Users and Groups			
Services		Description:				Search		
Catalog Items						Name A admin admin (configurationadmin@vsphere.local)		
Actions		Expiration Date:	•					
Entitlements		* Status:	Active		0			
Property Dictionary	>	Last Updated By:	admin admin					
Reclamation	>	Last Updated On:	3/19/19	10:25 PM	<u> </u>			
		Business Group:	Configuration Administrati	015				

Figure 48 Create entitlement

- The services (which must be entitled) are added first. Click the plus (+) sign next to the Entitled Services label.
- 4. Select the IBM Storage Entitlement service that was created and click OK.
- Click (+) next to the Entitled Items label and select Create and Map an IBM Storage Volume – Onpremise and -Cloud from the list in the new window, as shown in Figure 49.

Approval Policies	Edit Entitlement								
Directories Management >	General Items & Approvals								
Users & Groups >	Select the services, items, and actions to include in this entitlement. With the exception of actions and blueprint components, entitled items appear in the service catalog. Actions are available only after items								
Catalog Management V	are provisioned. To apply different levels of governance, you can configure individual services, items, and actions with different approval policies. You can change the approval policies associated with entitled items at any time.			1 entitled					
Condens	Entitled Services 💠		0	Entitled Items 🔶		0	Entitled Actions 💠		0
Services	Search			Search			Actions only apply to items defined in this entitlement		
Catalog Items	Name	Approval Policy		Name	Approval Policy		Search		
Actions	IBM Storage	(none)	•	Create and Map a Volume	(none)	•	Name	Approval Policy	
Actions							Delete a Volume (IBM Stor	(none)	•
Entitlements							Map a Volume (IBM Storag	(none)	
Property Dictionary >							Unmap a Volume (IBM Stor_	(none)	•

Figure 49 Entitled Services

- 6. Select the actions you want to permit to this entitlement. In this example, select **all** and ensure that the resource actions you created are selected. Click **OK**.
- 7. Click Add to create the entitlement.

VMware vRealize Automation: Service Execution

This section explains the procedure to run the services that were configured as described in section "VMware vRealize Automation configuration" on page 26.

Complete the following example steps to run a service:

 After the catalog item is configured under Administration (Administration → Catalog Management), log out and log in to refresh and a new tab (Catalog) is available, as shown in Figure 50. Click Catalog.



Figure 50 Service Catalog

On the Catalog tab, you see the catalog item that is populated with two options for creating and mapping an IBM Storage volume: On-premise and Cloud.

- 2. Click Request.
- 3. On the Step tab, click **Add** to add the IBM Storage System (On-premise or Cloud-Storage) from which the volume is to be created (see Figure 51).

Create and Map a Volume - Cloud Business group	Configuration Administrators V
* Service on which the volume should be created.	Select Cloud-storage [id-
\circledast *Name for the new volume. Valid name can only contain: a-z, A-Z, 0-9, $_{\rm coupt}$,+:	Select IBMStorage:StorageService
• * Size for the new volume (in GB).: • * initiators:	Spaces Spaces Services Cloud-Storage On-Premise V
	SELECT

Figure 51 Pool selection

- 4. Enter the name of the volume, the size (in GBs), and add the initiator details and click **Submit**. The request indicates if it was submitted successfully.
- 5. You can track the status of the request by clicking the **Deployment** tab. Successful completion of deployments requests are displayed (see Figure 52).

Catalog	Deployments	Design Inbox Administratio	n Infrastructure Containers		
eploym	ents 9items	T			
Search f	or deployments by	name, description, IP address, resource	e name or machine status		Sort: Created Date (descending) ~
۲	vol-oncloud		Created 22 days ago	Never expires	ACTIONS ~
Weightigt for Public Cloud	Owner Business group	admin admin Configuration Administrators			
~	wel test opp	(2)D	Created 32 days ago	Mouse autoiree	
CO France	vol-test-onprem	em	Created 22 days ago	rvever expires	ACTIONS
Public Cloud	Owner Burinerr group	admin admin Configuration Administrators			

Figure 52 Service request execution log

6. Click the request, then the details of the mapped volume created are displayed in the logs.

Similarly, you can create workflows for unmapped or deleted volumes (at on-premises or in Public cloud storage).

Summary

The deployment of multicloud environments with software-defined storage is growing in popularity with organizations.

IBM Spectrum Connect and IBM Spectrum Virtualize for Public Cloud running in IBM Cloud and AWS Cloud provides a perfect platform to enable software-defined storage capability. This capability is integrated with VMware vRealize Automation and VMware vRealize Orchestrator to provision IBM storage in a service delivery method.

The vRealize Orchestrator workflows that IBM defined for its storage provide an organization with the ability to efficiently manage the delivery of its storage resource by using vRealize Automation.

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